USSR Report

ENGINEERING AND EQUIPMENT

No. 68

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MECHANICS OF SOLIDS

TESTING AND MATERIALS

INVESTIGATION OF INTERELECTRODE STRENGTH IN THE CHANNELS OF OPEN-CYCLE MHD
GENERATORS

MAZUR, N. I., MIROSHNICHENKO, A. A., NALETOV, V. V. and SHUPIK, B. S.,
Institute of Electrodynamics, Academy of Sciences UkrSSR

[Abstract] The development of industrial MHD power plants requires research
on the reliability of elements in the MHD channel and improvement of energy
conversion efficiency on smaller facilities that enable analysis of separate
physical processes under conditions close to those in large industrial MHD
generators. One of these smaller installations is the K-I facility at the
Institute of Electrodynamics of the Ukrainian Academy of Sciences. This
paper gives the results of studies of interelectrode strength on this faci-
lity. Experiments were done on both induced and applied electric fields.
The insulators were specimens based on magnesium oxide MgO with various poro-
sity, structure and dopant content. Insulator width varied from 0.3 to 3 cm.
Analysis of the results of the experiments showed that the electric field
in the insulated gap is extremely nonuniform. This is attributed to non-
uniformity of temperature distribution, and hence nonuniform distribution
of conductivity as well. It is concluded that interelectrode breakdown in
MHD generators includes rapid electric breakdown of a thin layer near the elec-
trode, and slower thermal breakdown fo the entire dielectric. The role of
electric breakdown increases with a reduction in the width and temperature
of the dielectric. This electrothermal breakdown mechanism contradicts the
present general consensus of disruption of thermal equilibrium due to heating
of the interelectrode gap by high Hall current. Figures 3, references 3:
2 Russian, 1 Western.
[38-6610]

TECHNIQUE OF ACHIEVING HIGH-ENERGY ELECTRON BEAMS WITH LARGE CROSS-SECTION
(SURVEY)

BUGAYEV, S. P., KREYNDEL', YU. YE., and SHCHANIN, P.M., Institute of High-
Current Electronics of the Siberian Department of the USSR Academy of
Sciences, Tomsk

[Abstract] Various methods of producing high-energy electron beams with large
cross-section based on thermionic emission, explosive emission and electron
emission from various types of gaseous discharges are investigated. Pro-
blems of providing uniform current density distribution are discussed.
A characteristic feature of using beams of large cross-section is that the
object of irradiation is generally outside the vacuum chamber in which the
electron flux is formed. The electrons are usually extracted through thin
metal foils and sometimes through polymer films in the pusled mode. The
various types of devices and installations used to produce the electron beams
are described and diagrammed. Figures 20; references 50: 29 Russian;
21 Western.
[39-6521]

THE PERMISSIBLE INHOMOGENEITY OF THE RESISTANCE OF THE CONDUCTING COATING IN
AN ACCELERATOR TUBE

GAGEN-TORN, V. K. and REUTSKAYA, I. YE., Central Institute of Nuclear Re-
search, East German Academy of Sciences, Rossendorf

[Abstract] A method of determining the inhomogeneity of resistance in di-
electric accelerator tubes with conducting coating on the inner surface
is considered. If there is nonuniform resistance, a potential difference

appears in the gap between the section inductors and the coating of the accelerator tube and the necessity of ensuring electric strength imposes certain requirements on this nonuniformity. Expressions are derived to determine the potential difference between the accelerating section and conductive coating in any cross-section along the tube length. The permissible potential difference in the annular gap between the accelerating section and conductive coating of the LIU-30/250 linear induction accelerator is 30 kV, and is determined by the electric field intensity of the corona discharge. The proposed method permits one to select among tubes with conducting coating having different resistance distributions. Figures 2; references 4 Russian. [39-6521]

IMPROVING HEAVY ION ACCELERATION IN THE EGP-10-1 TANDEM GENERATOR

FRIDRIKH, M. and GYUNTSEL', R., Central Institute for Nuclear Research of the German Democratic Republic Academy of Sciences, Rossendorf

[Abstract] The ion trajectories of various charge states in an accelerator tube with sloping fields were calculated to improve heavy ion acceleration and to explain the resulting phenomena. Mathematical formulas are derived for calculating the electron trajectories in a tube with sloping fields. The calculating program was compiled in Fortran language to determine the particle trajectories. Figures 3; references 3: 1 Russian, 2 Western. [39-6521]

THE EFFECT OF CATHODE MATERIALS ON THE DISCHARGE PARAMETERS AND YIELD OF MULTIPLY CHARGED IONS

PASYUK, A. S., KUTNER, V. B. and TRET'YAKOV, YU. P., Joint Institute for Nuclear Research, Dubna

[Abstract] The results of testing some cathode materials of a multiply charged ion source are presented to find the highest yield of highly charged ions of the working gas and to provide reliability and sufficient operating

time of the source. Cathodes of different materials were investigated on a cyclotron multiply charged ion source. Niobium and zirconium carbide cathodes do not yield an increase of multiply charged ion intensity and do not increase the service life of the cathode. The operating reliability of the source is also reduced because of cracks appearing on the cathode. No significant difference in the yield of multiply charged ions is observed when molybdenum, rhenium, tungsten and tungsten-aluminum oxide and tungsten-rhenium cathodes are used. Tantalum cathodes provide an appreciable increase of multiply charged ions and more highly charged states. References 14: 10 Russian. 4 Western.
[39-6521]

INTENSE ION BEAM SOURCES WITH COMPENSATION OF THE POSITIVE SPACE CHARGE INSIDE THE ACCELERATING GAP

MAISHEV, YU. P.

[Abstract] Intense ion beam sources with compensation of the positive space charge inside the accelerating gap of the source by a negative space charge of electrons confined in crossed electric and magnetic fields were investigated. An ion source with closed electron drift having an annular slit in the accelerating electrode was developed to increase the ratio of the ion beam current to the total current and the electron confinement time inside the accelerating gap. The magnetic circuit cross-section was selected so that the ratio of the radial field to the longitudinal field in the discharge chamber was 3-5. Electrons from the beam plasma make the main contribution to the compensation effect. Electron compensation in the accelerating gap does not alter the energy spectrum of the ions compared to the uncompensated mode due to the absence of working gas ionization inside the accelerating gap by the compensation electrons; this is a significant practical advantage of the given sources. Figures 4; references 4: 3 Russian, 1 Western.
[39-6521]

A LOW-TEMPERATURE HIGH-PRESSURE OPTICAL CHAMBER

VOLOSHIN, V. A. and KAS'YANOV, A. I., Donetsk Physicotechnical Institute of the Ukrainian SSR Academy of Sciences

[Abstract] An optical chamber is described in which the windows and the medium transmitting the pressure are made of single crystal sodium chloride. The characteristic feature of the windows is that their material is compressed to maximum pressure near the specimen and they are under atmospheric pressure on the outer surface. Besides the spectrum of the studied material, the line spectra of ruby disks were also recorded. Expansion of the ruby lines due to nonuniform pressure remained constant within the range of 3.0 ± 0.6 kbar, but it usually decreased with an increase of pressure. An increase of the specimen dimensions due to the sodium chloride leads to an increase of nonuniform compression and a corresponding expansion of the ruby lines. A significant disadvantage of all these types of chambers is that they almost completely depolarize the light passing through them. Figures 2; references 6: 1 Russian, 5 Western.
[39-6521]

A SIMPLE SYSTEM FOR STABILIZING THE FREQUENCY OF A GAS LASER

GUDELEV, V. G. and YASINSKIY, V. M., Physics Institute of the BSSR Academy of Sciences, Minsk

[Abstract] A simple system for stabilizing the frequency of a gas laser based on microcircuits and transistors is described which can be used to stabilize the laser emission frequency both by the extreme points of the

amplification curve and in other methods in which synchronous detection is used to shape the error signal. The laser frequency is harmonically modulated by a piezoceramic cell that receives a signal sent from an audio-frequency oscillator through a DC amplifier. The laser output goes to a photocell, and the alternating component of the output of this sensor is amplified and sent to a synchronous detector. A phase shifter is used to compensate for phase distortions in the frequency stabilization system, and a shaper converts the sine-wave output from the phase shifter to meander square-wave pulses that control the transistor switches of the synchronous detector. The error signal from the detector output is converted to a laser frequency control signal with the use of static and astatic feedback circuits, thus taking advantage of the short lag of the static circuit and the low final error of the astatic circuit. The output signals from the feedback circuits are fed to different inputs of the differential DC amplifier, and the output of this amplifier is applied to the piezoceramic cell. The described system was used to stabilize the frequency of a helium-neon laser. Frequency stabilization of emission reached 10^{-10} within 15 minutes. Figures 2; references 3: 1 Russian. 2 Western.
[39-65]

A SYSTEM FOR STIMULATING ELECTRIC DISCHARGE EXCIMER LASERS

KOSTIN, M. N., TARASENKO, ". F. and FEDOROV, A. I., Institute of High-Current Electronics of the Siberian Department of the USSR Academy of Sciences, Tomsk

[Abstract] A simple laser with stimulation system based on strip lines of ceramic capacitors connected by Bloomline's symmetrical scheme in which lasing on excimer molecules of XeCl*, XeF* and KrF" was achieved is described. The best results during operation in the frequency mode were achieved with mixtures including $CHCl_3$. Figures 2; references 5:   3 Russian, 2 Western.
[39-6521]

A FLOW-THROUGH CUVETTE FOR OBTAINING THE INFRARED SPECTRA OF SURFACE COM-
POUNDS

LIKHTENSHTEYN, V. I., POPOV, V. K. and DOBROV, A. V.

[Abstract] A sealed flow-through heated cuvette is described for studying
the infrared spectra of surface compounds during adsorption without using
vacuum installations. Temperature is measured by a Chromel-Alumel thermo-
couple located close to the specimen. The specimen temperature is maintained
by a circuit containing a thermocouple and thyristor regulator and MR-64-02
millivoltmeter. The specimen surface is cleaned by heating prior to the
measurements with continuous removal of the desorbed substances by a gas
flow. The initial infrared spectrum of the adsorbent is recorded after the
surface is cleaned with continuous purging of the gas carrier, which ex-
cludes the entrance of adsorbates. Figures 3; references 4: 4 Russian.
[39-6521]

RESTORING THE DISCHARGE TUBES OF HELIUM-NEON LASERS

YERSHOV, A. S., KAZARIN, A. Yu. and YAKUNIN, V. G., Moscow State University

[Abstract] A method is proposed for restoring worn-out laser tubes and also
tubes which have not been used for a long time and which cannot be ignited
by ordinary methods. A high-voltage discharge produced by a UVCh-66 generator
is used for restoration. The process of restoration can be repeated many times
and individual tubes restored by the described method operate for more than
a year. The method can be used to restore almost 70 percent of laser tubes.
References 1: 1 Western.
[39-6521]

CONCERNING SOLUTION OF THE PROBLEM OF FINDING THE ENERGY CHARACTERISTICS
OF A CO_2 GASDYNAMIC LASER

MAKAROV, V. N., Moscow

[Abstract] The most important energy characteristic of a gasdynamic laser
is the power of the stimulated emission. The problem of optimizing gain
and specific lasing power can be solved by an efficient program for calculat-
ing a flow of relaxing gas in a nozzle and resonator cavity, and by using
efficient methods of finding the extremum of functions of many variables.
This paper gives a numerical solution for the problem of optimizing specific
lasing power in a gasdynamic laser based on carbon dioxide in mixtures with
helium and water vapor. A large number of versions of the functional to be
optimized are examined, and some singularities are pointed out that arise
at high initial pressures. The criterion functional is obtained by dividing
the absolute power by various characteristics of the system such as flowrate,
enthalpy, volume and so forth. The number of optimization parameters reached
to ten (initial conditions, composition, nozzle, resonator parameters).
It is shown that for certain functionals the results of optimization are
independent of the initial pressure preceding the nozzle inlet. The opti-
mization problem is solved for losses of up to 10% in the resonator cavity.
Figures 6, references 6 Russian.
[47-6610]

CALCULATIONS OF THE ENERGY CHARACTERISTICS OF MULTICOMPONENT WORKING FLUIDS
IN CO_2 GASDYNAMIC LASERS BASED ON COMBUSTION PRODUCTS

GENICH, A. P., KULIKOV, S. V. and MANELIS, G. B., Chernogolovka

[Abstract] As a rule, the working fluids for a CO_2 gasdynamic laser that
operates on combustion products of fuels with elementary composition con-
taining carbon, hydrogen, oxygen and nitrogen are multicomponent media.
At stagnation temperatures below 2000 K, they contain CO, O_2 and H_2 in
addition to the main components of CO_2, N_2 and H_2O. Preceding the nozzle
inlet, the multicomponent fluids are in total thermodynamic equilibrium.

For this reason, their lasing properties can be analyzed by a thermodynamic approach based on the elementary makeup, stagnation temperature and stagnation pressure of the complex fluid. In this paper the authors calculate the useful emission energy $\bar{W}$ that can be obtained from a unit of mass of the working fluid. The main calculations are done by an approximate method without consideration of the mutual influence of processes of vibrational kinetics, emission or gasdynamic flow in the resonator. More detailed calculations with consideration of this reciprocal effect were done to check the limits of applicability of the procedure. The results of the calculations are given on C-H-O ternary phase diagrams of the elementary compositions with fixed molar percentage of nitrogen as lines of equal values of the specific maximum energy available for extraction, and the specific energy output. Figures 2, references 17: 10 Russian, 7 Western.
[47-6610]

FLUID MECHANICS

INVESTIGATION OF FLOW AND HEAT EXCHANGE OF VISCOUS REACTING FLUIDS IN LONG PIPES

GRISHIN, A. M. and NEMIROVSKIY, V. B., Tomsk

[Abstract] Analytical and numerical solutions are found for the two-
dimensional problem of steady-state laminar flow of an incompressible vis-
cous inert or chemically reacting fluid in a long flat or cylindrical tube
at a constant flowrate. The fluid temperature at the inlet is given, and
the velocity profile at the inlet is taken as homogeneous or as corresponding
to a parabolic profile of Poiseuille flow. A constant temperature equal to
the inlet temperature is held on the noncatalytic walls of the pipe. Con-
ditions of thermal and hydrodynamic stabilization of the flow are determined,
and the particulars of highly viscous reacting fluid flow are analyzed.
Figures 5, references 23 Russian.
.48-6610]

INFLUENCE THAT ANISOTROPHY OF PERMEABILITY HAS ON CONVECTION AND HEAT TRANSFER IN A POROUS ANNULAR LAYER

BRAYLOVSKAYA, V. A., KOGAN, V.R. and POLEZHAYEV, V. I., Gor'kiy, Moscow

[Abstract] A numerical study is done on convection between tov infinite
coaxial cylinders with a porous material in the annulus that has appreciably
anisotropic permeability. The analysis is based on convection equations
in the Darcy-Boussinesq approximation. The permeability vector in the annulus
is constructed from the principal values of the problem, which can be
found experimentally. A method of calculation is worked out, and a

parametric study is done on flow structure, and on the localized and average characteristics of heat exchange that are of interest for design of thermal insulation. The results show that anisotropy of permeability has a considerable effect on heat transfer, and that thermal insulation can be made more effective by reducing the angular permeability which increasing the radial permeability of material with constant porosity in an annulus. Figures 5, references 8: 5 Russian, 3 Western.
[48-6610]

AN ELECTROSTATIC PROBE FOR REGISTRATION OF CHARGED PARTICLES IN A GASDYNAMIC FLOW

VATAZHIN, A. B. and RUSHAYLO, A. M., Moscow

[Abstract] An examination is made of the theoretical and practical aspects of using an electrostatic probe to register charged particles with radius of 50 um in a gasdynamic flow. An equation is derived that describes interaction between a charged particle and the flow, and a model problem is formulated and solved that quantifies the electrostatic charge on the probe. An analysis is made of the way that the probe interacts with conductive and dielectric particles. The study shows not only the possibility of registration of individual charged particles in a flow, but also demonstrates the feasibility of determining their charge and velocity on the basis of analysis of time distributions of the measured signal. Actual designs of an electrostatic probe and the corresponding measurement complexes are described. Ways are pointed out to improve sensitivity and resolution of the probe. A full-scale experiment is described in which a cylindrical probe was tested in reactive engine jets of gas-turbine aircraft engines. The results show that the proposed probe design has high mechanical strength, good thermal stability and a low noise level. The authors thank V. I. Grabovskiy, D. G. Dubravskiy, I. I. Il'yushenkova and A. P. Strekalov for assisting with the work. Figures 6, references 6: 5 Russian, 1 Western.
[48-6610]

UDC 533.6.011.5

SOME PARTICULARS OF INTERACTION OF STRONG BLOW-IN WITH AN OPPOSED SUPER-
SONIC FLOW

9Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 1, Jan/Feb 80 pp 91-98 manuscript received 27 Nov 78

KOVAL', M. A., STULOV, V. P. and SHVETS, A. I., Moscow

999999999999

[Abstract] An analysis is made of the interaction of a gas stream with an
oncoming flow in the case of forcible injection from the flat end of a
cylinder. It is assumed that the main supersonic gas flow and the injected
gas are homogeneous and ideal. The Mach number of the oncoming flow ranges
from 2 to 8. The interaction takes place at Reynolds numbers such that the
mixing layer separating the two flows is thin enough to be represented by
a contact surface, so that the problem can be solved in Euler equations.
The results are compared with experimental data on shock wave parameters,
the thickness of the injection layer on the axis, and pressure distribution
on the end face of the cylinder. The downwash of the injected gas on the
periphery of a porous end face is determined. It is shown that the contact
surface approaches some limiting position, i. e. its shape is stabilized
as the Mach number of the oncoming flow increases at the same injection para-
meter K (ratio of velocity head of the injected gas to that of the oncoming
flow) and for a given distribution of K over the surface of the body. An
estimate is made of the influence that the adiabatic exponent has on the
thickness of the blow-in layer. Figures 6, references 12 Russian.
[48-6610]

UDC 533.6.011.72

ON THE CENTER OF PRESSURE OF CONICAL BODIES

OSTAPENKO, N. A., Moscow, Institute of Mechanics, Moscow State University

[Abstract] The author considers the problem of supersonic flow without
slip around a conical body that is symmetric relative to the yz plane.

Shapes of such bodies are found for which the position of the center of pressure is independent of flow parameters. It is shown that the position of the center of pressure of a stellated cone is relatively independent of the angle of attack for low ratios r/L, where r is the distance from an inner edge of the stellated body to the z-axis in its middle cross section, and L is the length of the body. The position of the center of pressure of an elliptical cone in a supersonic flow with a plane of symmetry is found to be completely determined by the ratio of a semi-axis of the ellipse in the middle section of the cone lying in the plane of symmetry to the length of the cone, and is independent of the flow parameters. Figures 5, references 4 Russian.
[48-6610]

IONIZATION AND NONEQUILIBRIUM RADIATION OF AIR BEHIND STRONG SHOCK WAVES

ZALOGIN, G. N., LUNEV, V. V. and PLASTININ, YU. A., Moscow

[Abstract] An investigation is made of the problem of ionization relaxation and radiation of air behind shock waves on the basis of a simplified approach with consideration of the kinetic equation for the population of one excited state. It is shown that at high shock wave velocities (of the order of 9.5 km/s or more), the depletion of excited states of atoms due to luminescence has a decisive effect on ionization rate. In the case of pressures of the order of 1 mm Hg or less, when the region of the heated gas shock wave is bounded and optically transparent, the effective ionization rate constant is pressure-dependent, which violates the law of binary similitude that is valid under these conditions when luminescence is disregarded. At the outlet of the relaxation zone the gas arrives at a certain steady state with constant parameters different from thermodynamic equilibrium. Both the electron concentrations and the emission intensity in the continuous spectrum and atomic lines are lower than for the thermodynamic equilibrium values. It is concluded that the reduction in the rate of ionization of atoms by electron impact when the distribution with respect to excited states is not boltzmannian must be taken into consideration in shock tube experiments and in calculations of the flow around blunt bodies at velocities of more than 9.5 km/s and pressures lower than 1 mm Hg. Figures 5, references 20: 16 Russian, 4 Western.
[48-6610]

THE THERMAL ACTION OF STRONGLY UNDEREXPANDED JETS ON STRUCTURAL ELEMENTS OF
VEHICLES OF COMPLICATED SHAPE

BALASHOV, YU. P., GERASIMOV, YU. I., PLOTNIKOV, B. P., RESHETIN, A. G.
and SHKLYAYEV, P. N., Moscow

[Abstract] In preparing for the Soyuz-Apollo mission, model tests were
done to determine the thermal and force effects of jets of the Apollo
reactive engine control system acting on the Soyuz vehicle. These experi-
ments showed the complicated structure of the field of gas flow with its
system of compression shocks and regions of rarefaction. The experimentally
determined heat fluxes were scaled up to full mission conditions by a method
based on relations for calculating the thermal action of a supersonic gas
jet on a body of arbitrary shape. Cylindrical calorimeters mounted on the
spacecraft made it possible to compare the heat fluxes recorded in the joint
mission with those calculated by this method. This paper describes the tech-
nique used to scale up experimental scale model heat fluxes to full flight
conditions. The calorimeter design is described as well as the conditions
under which the measurements were made of the heat fluxes from the engine
jets of the Apollo. The sub-scale and full-scale results are compared,
and it is shown that the proposed scale model technique and the method of
scaling up the data are sound. Figures 5, references 10: 9 Russian, 1
Western.
[48-6610]

PRESSURE PULSATIONS ON A BARRIER WITH AN IMPINGING JET

KUPTSOV, V. M., SYRCHIN, A. F., FILIPPOV, K. N. and KHAR'KOV, V. D.,
Moscow

[Abstract] A number of studies have been done on the self-oscillations
that arise when a supersonic imperfectly expanded jet interacts with a
barrier perpendicular to its vector. Although less attention has been
given to the pressure pulsations at a barrier in the absence of self-
oscillations, in many instances the highest total pressure pulsation levels
are observed when a barrier is situated fairly far from the nozzle tip, and
pressure pulsations are random. In this paper the authors consider pressure
pulsations on a plate perpendicular to a supersonic jet far from perfect
expansion. Puslation characteristics are measured with the barrier situated
so that self-oscillations do not arise. Relations are derived that generalize
the results of measurement of pulsation characteristics at both subsonic and
supersonic velocities on the jet axis immediately preceding the barrier.
An investigation is also made of correlation of pressure pulsations on the
plate with external acoustic noise. An expression is found for the level
of acoustic noise as a function of maximum pressure pulsations on the
plate. Figures 5, references 9: 8 Russian, 1 Western.
[48-6610]

HEAT TRANSFER IN A STRONGLY RAREFIED GAS

FRIDLENDER, O. G., Moscow

[Abstract] The author considers the two-dimensional problem of heat
transfer in a rarefied molecular gas between two parallel plates heated

to different temperatures. It is assumed that the molecules leave the plates with maxwellian distribution corresponding to these temperatures, and that the gas is initially in the free-molecular state. An investigation is made of the nonmonotonic behavior of heat flux between the plates as the temperature of one of them is lowered. A paradox arises in this problem when accommodation coefficients are used to describe the interaction between gas molecules and the surface. It is concluded that the law of interaction between surface and molecules must be taken into consideration along with the accommodation coefficient for calculating heat transfer in a strongly rarefied gas at high temperature differentials. Figures 2, references 4: 2 Russian, 2 Western.
[48-6610]

INVESTIGATION OF THE INFLUENCE THAT BLOW-IN HAS ON FLOW IN A HYPERSONIC VISCOUS SHOCK LAYER CLOSE TO THE STAGNATION LINE OF A BLUNT BODY

GERSHBEYN, E. A. and KOLESNIKOV, A. F., Moscow

[Abstract] Axisymmetric flow of a homogeneous gas in a shock layer that includes the region of transition through compression shocks is considered in the locally self-similar approximation of Navier-Stokes equations. The boundary conditions that account for gas injection are assigned on the surface of the body and in the undisturbed flow. A numerical solution is found for the problem over a wide range of Reynolds numbers and blow-in parameters. It is shown how the coefficients of friction and heat exchange on the surface of the body as adjusted to their values when the blow-in parameter is equal to zero depend on the blow-in parameter that is ordinarily used in boundary layer theory. The results show that these relations are universal and that they coincide with similar relations found by solving equations of a hypersonic viscous shock layer with modified Rankine-Hugoniot relations on the shock wave, and also from the solution of boundary layer equations. At low Reynolds numbers, the blow-in has little influence at low specific flowrates on the nature of flow in the shock layer, or on the thermal fluxes and coefficient of friction on the surface of the body. With increasing Reynolds number at a fixed flowrate, the effect of the blow-in is intensified. Figures 5, references 15: 13 Russian, 2 Western.
[48-6610]

EXPERIMENTAL STUDY OF FLOW OF A VIBRATIONALLY NONEQUILIBRIUM GAS IN A PROFILED NOZZLE

BRITAN, A. B., SERIKOV, R. I., STARIK, A. M. and KHAYLOV, V. M., Moscow

[Abstract] The paper gives the results of measurements of lasing gain in a flat profiled nozzle for a gas mixture containing carbon dioxide, nitrogen, and traces of oxygen and water vapor. A shock tube technique was used with a nozzle having a geometric degree of expansion of 16 and a critical cross section height of 4.34 mm. Initial working gas temperatures were varied from 1600 to 2100 K, and pressures ranged from 3 to 7 absolute atmospheres. It was found that the acutal flow structure in a profiled nozzle has an appreciable influence on the process of population inversion. It is emphasized that the theoretical description of the behavior of nonequilibrium flow parameters in the one-dimensional approximation cannot be generalized to flow at all points inside the nozzle. The authors thank V. A. Poltoratskiy for assisting with the experiments, and G. D. Smekhov and S. A. Losev for useful discussions. Figures 5, references 13: 11 Russian, 2 Western.
[48-6610]

OSCILLATIONS OF A WEDGE IN A NARROW CAVITY (PART II)

SEVEROV, S. P., candidate of technical sciences

[Abstract] The first part of this paper was published in "IVUZ: Mashinostroyeniye," No 5, 1978. An investigation is made of self-oscillations of a wedge in a restrictive gap between the free boundaries of a fluid flow.

Phase trajectories are given that asymptotically approach a certain limiting
cycle from within and from without. Oscillations of the wedge are con-
sidered in the plane perpendicular to the plane of symmetry of the channel.
The calculations are generalized to angular oscillations of a prismatic wedge
in a flat cavity. Approximate calculation by the method of planar cross
sections is confirmed by experimental data. The results show that self-
oscillatory movements of a wedge can arise as it glides along the boundaries
of a narrow cavern. Figures 3, reference 1 Russian.
[44-6610]

ON THE INFLUENCE THAT THE CHORD OF WORKING VANES HAS ON LOSSES IN THE RADIAL
GAP OF AN AXIAL TURBINE

MOLYAKOV, V. D., candidate of technical sciences, and KUNIKEYEV, B. A.,
engineer

[Abstract] A brief analysis is made of the current state of research on
the losses in the radial clearance of an axial turbine stage. Test results
are given for three runners that differ only in the chord b of the working
blades to determine the way that the aspect ratio of the blades influences
the losses in the radial gap over the working blades. It is found that
existing data for determining losses in this region as a function of the
relative clearance $\bar{\delta}_b = \delta_r/b$ (where δ_r is the radial clearance) and as a
function of aspect ratio $\bar{l} = l/b$ (where l is blade height) need to be more
precisely specified since most experiments have varied the blade aspect
ratio mainly by changing blade height, and the parameter δ_b has been varied
by changing the radial clearance without changing the chord. The analysis
given in this research shows that losses in the radial gap decrease with
an increase in the chord of blades in the runner of an unshrouded axial
turbine. Figure 1, references 8: 6 Russian, 2 Western.
[44-6610]

UDC 536.2

RADIATIVE-CONDUCTIVE HEAT EXCHANGE IN A THIN TRANSLUCENT CYLINDER IN THE
LIGHT GUIDE 'APPROXIMATION

YUFEREV, V. S., Leningrad

[Abstract] An examination is made of heat exchange in a thin circular cy-
linder surrounded by a cylindrical shield with axisymmetric temperature
distribution. The space between the cylinder and shield is evacuated or
else filled with a gas with insignificant absorption. The following
conditions are assumed: $d/z \ll 1$, $kd \ll 1$, $a/z \ll 1$, where d is the diameter of
the cylinder, z is the length of the cylinder, k is the absorption factor,
a is the distance between the cylinder and the shield. The lateral surface
of the cylinder is taken as transparent and mirror-reflective, and the co-
efficient of heat conduction is taken as isotropic. It is further assumed
that there is no scattering, and that the coefficient of absorption is
independent of temperature and frequency. One base of the cylinder is hot
and ideally black, and the other end is cold and diffusely reflective.
A one-dimensional formula is derived for temperature calculation with con-
sideration of only that part of the radiative energy transport that corres-
ponds to the progagation of radiation through the cylinder as a light guide.
An approximate expression is proposed for calculating the emission of the
shield. A numerical example is given of temperature calculation in a sap-
phire rod. The author thanks E. A. Tropp for constructive discussion.
Figures 3, references 3 Russian.
[47-6610]

CONVECTIVE MASS EXCHANGE IN A SYSTEM OF PERIODICALLY ARRANGED SPHERES

GUPALO, YU. P., POLYANIN, A. D., RYAZANTSEV, YU. S. and SERGEYEV, YU. A.,
Moscow

[Abstract] An analysis is made of steady-state convective diffusion in a
laminar flow of viscous incompressible fluid filtering through a system or
reacting spheres of equal radius arranged in a cubic lattice, assuming
that the ratio of the lattice period to the radius of a sphere is much greater
than the cube root of the Péclet number of an isolated sphere. The mean rate
of filtration flow between spheres is taken as U with vector parallel to one
of the axes of the lattice, and the Reynolds number $Re=aU/v$ is taken as small
(where v is the kinematic viscosity of the fluid). An expression is found
for the distribution of average concentration in the direction of the flow
with consideration of the interaction of diffusion wakes and the boundary
layers of the lattice particles. References 9: 6 Russian, 3 Western.
[47-6610]

THICKNESS OF LUBRICANT LAYER AND ROLLING RESISTANCE IN ELASTIC-HYDRODYNAMIC
CONTACT OF CYLINDERS

GALAKHOV, M. A., ZAPPAROV, K. I. and PATRAKOV, A. G., Moscow

[Abstract] Various methods have been used previously to get formulas
for calculating the average layer of lubricant in elastic-hydrodynamic con-
tact of cylinders, but little attention has been devoted to the related
problem of determining the rolling resistance of two elastic cylinders
separated by a layer of viscous liquid. Formulas are proposed in this
paper for the average and minimum thickness of a layer of lubricant, and also

for rolling resistance. The method of deriving the formulas is based on analysis of the results of diect numerical solution of equations of the isothermal elastic-hydrodynamic problem. The expressions are compared with experimental data. The case of restricted supply of lubricant to the contact zone is considered. The authors thank L. V. Ovsyannikov for constructive discussion of the work. Figures 4, references 9: 6 Russian, 3 Western. [47-6610]

DIAGNOSIS OF THE MAJOR TURBULENCE CHARACTERISTICS OF TWO-PHASE FLOWS

BURDUKOV, A. P., KASHINSKIY, O. N., MALKOV, V. A. and ODNORAL, V. P., Novosibirsk

[Abstract] Research on two-phase gas-liquid flows has recently shifted emphasis from measurement of averaged characteristics to a detailed study of turbulence structure. For a number of years the Institute of Thermal Physics of the Siberian Department, Academy of Sciences of the USSR, has been doing research on the turbulence characteristics of gas-liquid flows. This paper describes a technique for determining the principal characteristics of such a flow: friction stress at the wall, distributions of the localized gas content and the velocities of liquid and gas, and pulsation characteristics. The method utilizes electrochemichal and electrical conductivity measurements. Figures 7, references 17: 7 Russian, 10 Western. [47-6610]

EXPERIMENTAL STUDY OF TRANSONIC AND SUPERSONIC ANNULAR JETS

KOVAL, M. A. and SHVETS, A. I., Khar'kov, Moscow

[Abstract] Previous experimental research on supersonic plug nozzle flow has established the influence that the Mach number and overexpansion or underexpansion have on base pressure, and has shown the principal conditions of flow in annular jets. However, there has been little investigation of

the influence that the relative dimensions of plug nozzles and the shaping
of the flow section have on flow. This paper gives the results of experi-
mental studies done on three transonic and three supersonic jets discharged
from plug nozzles with a flat tip. It is shown that for transonic annular
jets there are several bands of overexpansion or underexpansion for an
open jet, and one band for a closed jet, typified by a monotonic change in
base pressure as a function of overexpansion or underexpansion, and also
with a corresponding comparatively stable flow spectrum. It is shown that
the base pressure and geometric structure of shock waves in the jets are
appreciably affected by the ratio of the nozzle diameter to the plug dia-
meter, and also by their shape. Closed supersonic or transonic jets are
produced by covering the base region with a near-sonic throat located within
the first "barrel." In the closed transonic jet mode the pressure is not
uniform over the tip face of the nozzle with maximum pressure along the
axis. Figures 6, references 4 Russian.
[47-6610]

AERODYNAMIC FORCES THAT ACT ON THE BLADES OF A THREE-DIMENSIONAL ANNULAR
CASCADE IN THE UNSTEADY FLOW MODE

RYABCHENKO, V. P., Novosibirsk

[Abstract] The paper gives the computer solution of the three-dimensional
problem of unsteady flow of a vortex-free ideal incompressible fluid at
given axial velocity through a row of blades that turn with constant
angular velocity in a coaxial cylindrical channel of infinite length. It
is assumed that the blades may undergo synchronous steady-state harmonic
oscillations of small amplitude with given frequency and constant phase
shift. The solution is based on the vortex theory of a screw and of a wing
of finite span. An investigation is made of the influence that cascade
parameters and Strouhal number have on distributed and resultant aerodynamic
forces that act on the blades. In the case of flexural-torsional vibrations,
the results of the calculation are compared with known data of the two-
dimensional theory. It is shown that the influence of three-dimensional
effects is considerable when stagger is large, especially in the region of
small Strouhal numbers. Figures 6, references 7: 5 Russian, 2 Western.
[47-6610]

MECHANICS OF SOLIDS

AXISYMMETRIC CONTACT BETWEEN TWO THICK-WALLED SHELLS WITH CONSIDERATION OF
THE ROUGHNESS OF THE FITTING SURFACES

KHVOROSTUKHIN, L. A., doctor of technical sciences, professor, and SHISHKIN,
S. V., graduate student

[Abstract] An engineering method is developed for strength calculation
of pressed joints with consideration of the actual shape of the parts that
are joined and the quality of technological preparation of the fitting sur-
faces. The analysis is based on numerical solution of the axisymmetric
contact problem of tension joining of two thick-walled shells of different
length with allowance for surface roughness between the contacting parts.
The finite element method is used for determining influence functions to
account for the damping effect of the reduced concentration of contact
stresses on the mating parts due to surface roughness.   The actual pro-
perties of the microgeometry of the mating surfaces on the contact boundary
are accounted for by introducing a linearly elastic layer that has the fol-
lowing properties: 1. deformations of the contact layer are strictly local
and independent of the displacements of the mating parts; 2. mutual in-
fluence of contact deformations is disregarded, i.e., displacement of any
section of the boundary layer is independent of the displacements of other
sections; 3. deformation of the linearly elastic layer is directly propor-
tional to the applied contact pressure, i. e. the contact displacement at
any point of the layer is given by $\xi = \eta q$, where η is the contact compliance of
the linearly elastic layer. Figures 3, references 3: 2 Russian, 1 Western.
[46-6610]

INFLUENCE THAT COMPRESSIBILITY OF THE FILLER HAS ON THE STRESS-STRAIN STATE
OF A SANDWICH SHELL

BAKULIN, V. N., engineer

[Abstract] In calculating sandwich shells it is frequently necessary to
determine the stressed and strained state due to a radial load on one of
the outer layers. In the case of local loading, it is generally assumed
that the filler has no transverse compressibility, which considerably
simplifies calculation, but leads to considerable errors. In this paper the
author considers a cylindrical sandwich shell resting on the outer layers
on one end and loaded by an annular radial force on the outside layer at
the other end. The stress-strain state is analyzed for different ratios of
elastic moduli of the filler and outer layers. The analysis is based on
the finite element method, using a finite element of a sandwich shell with
outer layers conforming to the Kirchhoff-Love hypothesis, and assuming that
strains are due to transverse shearing and compression in the radial direct-
ion in the filler. Graphs are given for the parameters of the stressed and
strained state of the shell as a function of the ratio of elastic moduli
of outside layers to elastic moduli of the filler. Figures 2, references
4 Russian.
[46-6610]

A SYSTEM FOR AUTOMATIC DETERMINATION OF CHARGED PARTICLE PATHS IN A MAGNETIC FIELD

BABAYAN, A. Z. and TUMANYAN, A. R.

[Abstract] A system which provides automatic measurement of the coordinates of a continuously moving wire with discrete control of spacing and the range of measurements and also the values of current in the wire over a wide range according to a given program is described. The system is connected to a computer for simultaneous recording and processing of the values of the coordinates and current of the wire and also the magnetic field intensity of the measured electromagnet. The measurement accuracy was increased and the time and work of investigating the magnetic channels were reduced significantly through automation of all the main measurement processes. The proposed system was used with good results in determining the charged particle paths in one of the extraction channels of the Yerevan synchrotron. Figures 3; references 7: 6 Russian, 1 Western.
[39-6521]

A NOISE-RESISTANT SYSTEM FOR MEASURING THE BEAM INTENSITY OF CHARGED PARTICLES

PROTASOV, A. K., RYBIN, V. M. and SUKHIN, V. N.

[Abstract] The system was developed for measuring beam intensity using an acoustic transducer to increase the signal-noise ratio. Measuring the beam intensity of charged particles by using an acoustic transducer is based on the fact that the amplitude of the acoustic signal generated by

the beam in the target is linearly dependent on the number of particles in the pulse of the beam current. The system can be used to measure beam intensities up to $5 \cdot 10^7$ electrons per pulse with signal-noise ratio of not less than 30 dB. Figures 3; references 4: 3 Russian, 1 Western.
[39-6521]

WIRE RESISTORS THAT TOLERATE MULTIPLE COOLING TO LIQUID HELIUM TEMPERATURE

PANKRATOV, N. A., NARYKIN, N. I. and MALYAROV, V. G.

[Abstract] Small wire resistors are described that have comparatively low reactivity, are efficient upon cooling to liquid helium temperature and can have practically any resistance values. Nichrome wire is wound around the body with alternation of the direction of rotation of the body after a specific number of turns. This method of winding uses half as much wire as parallel winding and is the simplest of special windings used to manufacture high-frequency wire resistors. The number of reversals should be odd and sufficiently large to reduce inherent reactances. Figures 2; references 2: 2 Russian.
[39-6521]

A MULTICHANNEL STROBOSCOPIC SIGNAL ANALYZER

USTINOV, B. P., ANDREYENKO, A. A., BARANCHIKOV, V. M., MALEVICH, I. A., SOVTUS, V. G. and CHUBAROV, S. I.

[Abstract] An analyzer for investigating the kinetics of molecular systems stimulated by laser emission and which permits analysis of the form of the investigated process in the presence of uncorrelated and correlated emission detector noise is described. The method of multichannel strobing of the photodetector signal with subsequent analog-digital conversion of the quantized signal and parallel addition of the digital equivalents of estimates in the multichannel storage device of the analyzer is the basis of the system.

The scales of the storage access cycles and of the analog-digital converters are shaped from the signals of the base time scale. The total accuracy of analog-digital conversion is 0.5 percent, the capacity of a single storage channel is in the range of 10^3-10^8 and the number of storage cycles is 10^6. Figure 1.
[39-6521]

A MULTICHANNEL RECORDER OF SINGLE PULSE SIGNAL PARAMETERS

POPOV, A. P. and KUZNETSOV, YE. M.

[Abstract] A device designed to operate with voltage sensors is described. The device records single pulse amplitudes and pulse length from the moment the signal appears to the maximum (peak) value. The recorder can also be used to record pulse amplitudes with repetition rate up to 40 kHz. The operating principle of the device is based on conversion of pulse parameters at the constant voltage level and storage and measurement of the levels by digital voltmeter with subsequent channel interrogation. Figure 1.
[39-6521]

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